Control

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Reports Solutions:-

For the system has O.L.T.F = GH(s), prove that

$$K = \frac{\pi P_i}{\pi z_i}$$

Solution

$$O.L.T.F = GH(s)$$

$$C.L.T.F = \frac{K\,GH(s)}{1 + K\,GH(s)}$$

$$ch.\ eqn = 1 + K\,GH(s) = 0$$

$$K\,GH(s) = -1 = 1 \angle 180$$

GH(s) : Function in complex variable

$$s = \sigma + j\omega$$

$$\|K\,GH(s)\| = 1$$

$$\times \ \angle K\,GH(s) = 180$$

$$K = \frac{1}{\|GH(s)\|}$$

$$GH(s) = \frac{(s+z_1)(s+z_2)\cdots}{(s+P_1)(s+P_2)\cdots}$$

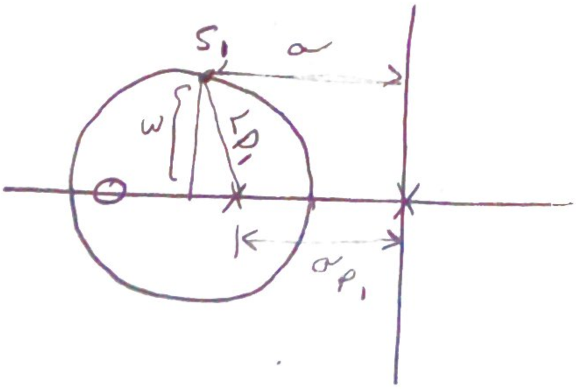
$$\|GH(s)\| = \frac{|s+z_1|\,|s+z_2|\cdots}{|s+P_1|\,|s+P_2|\cdots}$$

$$\boxed{S = \sigma + j\omega}$$ hint: $a+jb \Rightarrow \sqrt{a^2+b^2}$

$$\|GH(s)\| = \frac{|\sigma + j\omega + z_1| \cdots}{|\sigma + j\omega + P_1| \cdots}$$

$$= \frac{\sqrt{Re_{z_1}^2 + Img_{z_1}^2} + \sqrt{\cdots}}{\sqrt{Re_{P_1}^2 + Img_{P_1}^2} + \cdots}$$

$$= \frac{L_{z_1}\, L_{z_2} \cdots}{L_{P_1}\, L_{P_2} \cdots}$$



$$\therefore \quad GH(s) = \frac{\Pi\, l_{z_i}}{\Pi\, l_{P_i}}$$

$$\Rightarrow K = \frac{\Pi\, l_{P_i}}{\Pi\, l_{z_i}}$$

where l_{z_i} = the length of line between the open loop zero and the considered closed loop pole (S_1)

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* departure angel from complex poles

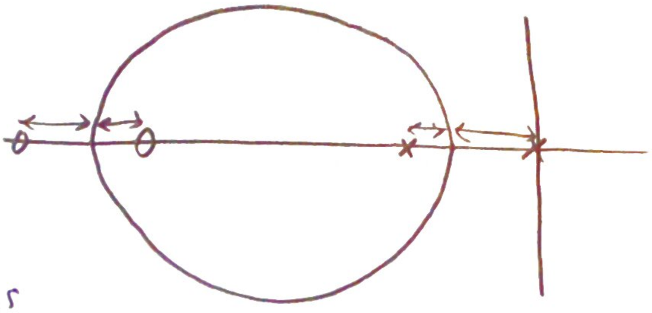
$$\theta_d = 180 - \phi_P + \phi_z$$

* Arrival angle to complex zeros.

$$\theta_a = 180 - \phi_z + \phi_P$$

تصحيح خطأ في مسألة

$$GH(s) = \frac{K(s+2)(s+3)}{s(s+1)}$$



Breaking points

Breaking out ⇒ was correct ✓

Breaking in ⇒ was incorrect ✗

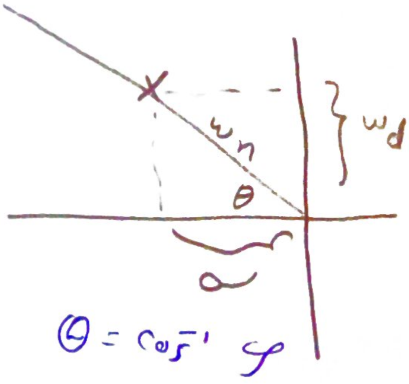
Correction ⇒ root locus Breaking in moves (between zeros) little to the right not to the left.

C.L. Poles

$\omega_d = \omega_n\sqrt{1-\zeta^2}$

$\sigma = \zeta\omega_n$

$\omega_n = \sqrt{\omega_d^2 + \sigma^2}$



system speed depends on time constant

τ : time for the system to reach 63% of the response

$\tau = \frac{1}{\sigma}$

settling time $t_s = 4\tau = \frac{4}{\sigma}$

Matlab code

```
num = [1 4 16];
den = [1 4 8 0];
G = tf (num, den);
rlocus (G)
sisotool
rlocus (G)
```